



ATTAM/EOA Steering Committee Update

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February 21, 2023



NASA Aeronautics – Vision for Aviation in the 21st Century



6 Strategic Thrusts



Safe, Efficient Growth
in Global Operations



Innovation in Commercial
Supersonic Aircraft



Ultra-Efficient Subsonic
Transports



Safe, Quiet, and Affordable
Vertical Lift Air Vehicles



In-Time System-Wide
Safety Assurance



Assured Autonomy for
Aviation Transformation

ARMD continues
to evolve and
execute the
Aeronautics Strategy
[https://www.nasa.gov/
aeroresearch/strategy](https://www.nasa.gov/aeroresearch/strategy)

U.S. leadership for a new era of flight



Research Programs Align with Strategic Thrusts

MISSION PROGRAMS

Airspace Operations & Safety (AOSP)



PROJECTS

- Advanced Air Mobility
- Advanced Capabilities for Emergency Response Operations
- ATM-X
- System-Wide Safety



Advanced Air Vehicles Program (AAVP)



PROJECTS

- Advanced Air Transport Technology
- Hybrid Thermally Efficient Core
- Hi-Rate Composite Aircraft Manufacturing
- Commercial Supersonic Technology
- Revolutionary Vertical Lift Technology
- Hypersonic Technology



Integrated Aviation Systems Program (IASP)



PROJECTS

- Electrified Powertrain Flight Demonstration
- Flight Demonstrations and Capabilities
- Low Boom Flight Demonstrator
- Sustainable Flight Demonstrator



Integration & Flight

SEEDLING PROGRAM

Transformative Aeronautics Concepts Program (TACP)



PROJECTS

- Convergent Aeronautics Solutions
- Transformational Tools & Technologies
- University Innovation



PORTFOLIO OFFICE

Aerosciences Evaluation and Test Capabilities (AETC)



GROUND FACILITIES

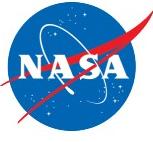
- Subsonic
- Transonic
- Supersonic

Hypersonic

Propulsion

Test Technology





Thrust 2: Innovation in Commercial Supersonic Aircraft



High-Speed Commercial Flight

Sustainable transformation of the speed of air travel



Addressing the unique barriers to sustainable,
environmentally responsible high-speed flight

The Quesst
Mission generates
key data to support
development of en
route certification
standards based on
acceptable sound
levels



X-59 Construction and Testing



Complete X-59 Build in Fall 2022
Achieve First Flight in 2023

Quesst Mission Overview

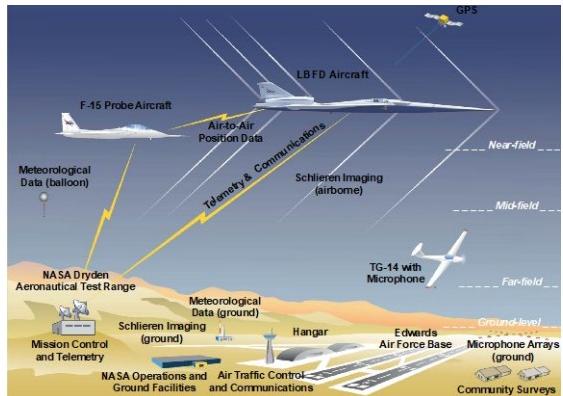


QUESST

Phase 1 – Aircraft Development

In progress (FY18-23)

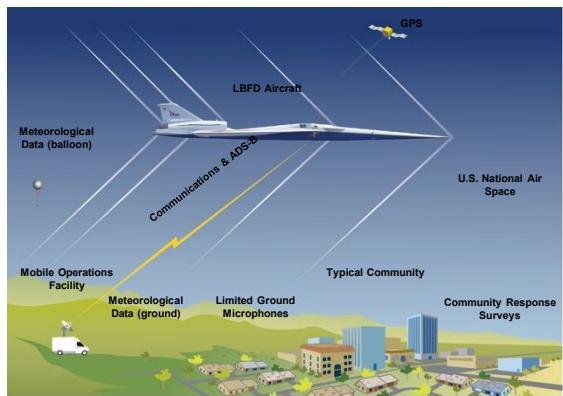
- Design, fabricate a quiet supersonic research aircraft
- Prove performance in test range flights
- Prove safety for flights in normal airspace



Phase 2 – Acoustic Validation

Preparation in progress (FY18-23), Execution 2024

- Prove the acoustic characteristics match design targets
- Detailed in-flight and ground measurements in test range



Phase 3 – Community Response Testing

Preparation in progress (FY19-23), Execution 2025-27

- Conduct community tests
 - Select communities
 - Outreach and engagement (including STEM)
 - Obtain necessary approval
 - Plan surveys and recruit participants
 - Collect ground measurements

Systematic Approach Leading to Community Testing

Acoustic Validation & Community Response Testing Preparations



*Site selection process developed,
and survey plan baselined*



*V&V-driven design update for
production Ground Recording
System units*

*GRS prototype deployed during
CarpetDIEM2 test*



*Test planning & hardware development
are making significant progress toward readiness*

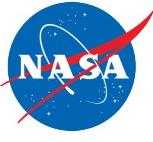
Landing and Takeoff Noise



Acoustic data from flight and rig tests will improve noise predictions used in studies of environmental impact of future supersonic aircraft.



Quantifying the impact of future aircraft on airport noise.



Thrust 3: Ultra-Efficient Subsonic Transports



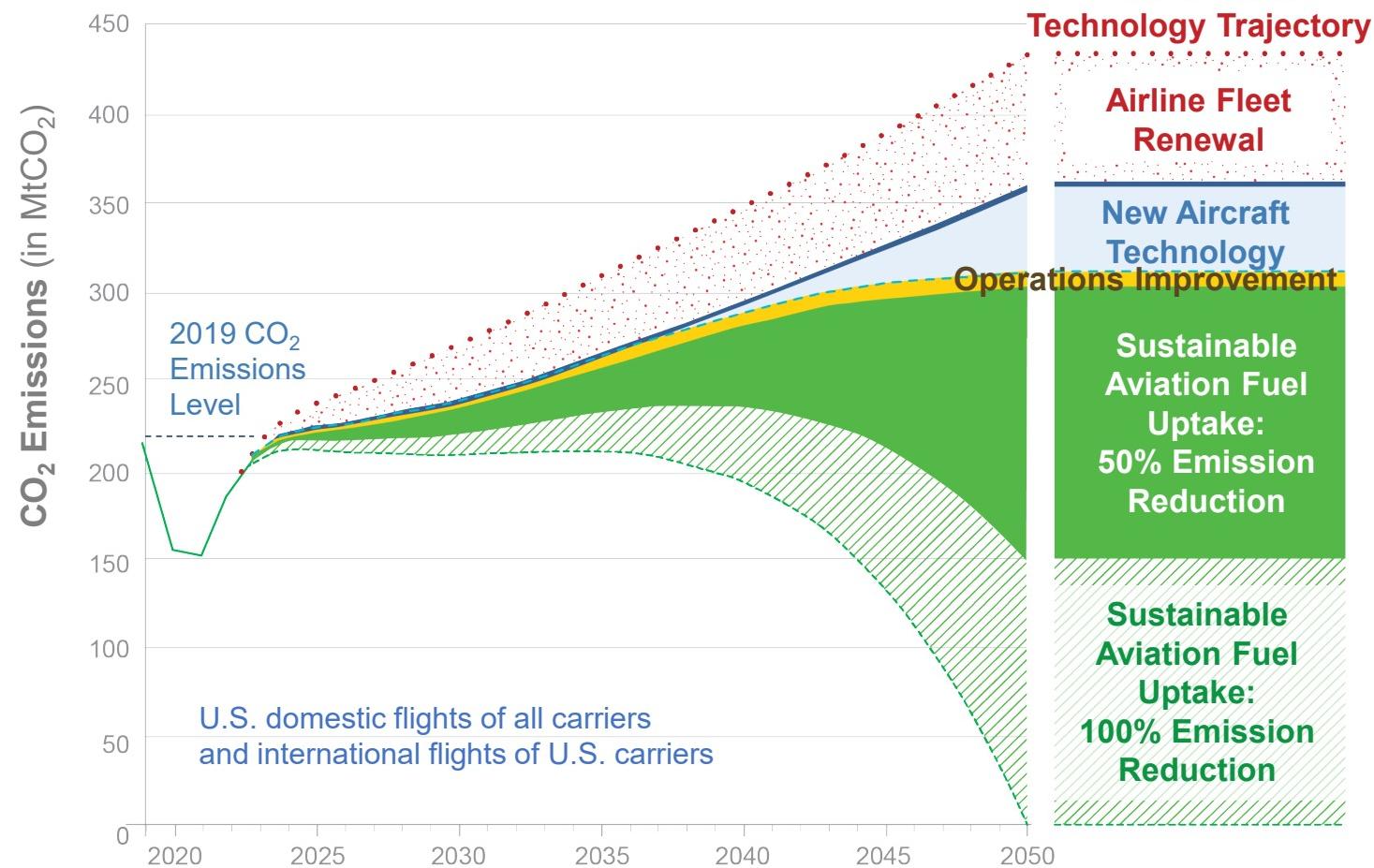
U.S. Aviation Climate Action Plan

Global Context for Sustainable Aviation

U.S. aviation goal is to achieve
net-zero greenhouse gas emissions by 2050.

U.S. Aviation Climate Action Plan is aligned with

- U.S. economy-wide goal
- International Civil Aviation Organization
- Air Transport Action Group



https://www.faa.gov/sites/faa.gov/files/2021-11/Aviation_Climate_Action_Plan.pdf

The U.S. is working with the global community to achieve net-zero greenhouse gas emissions by 2050 using a common basket of measures.



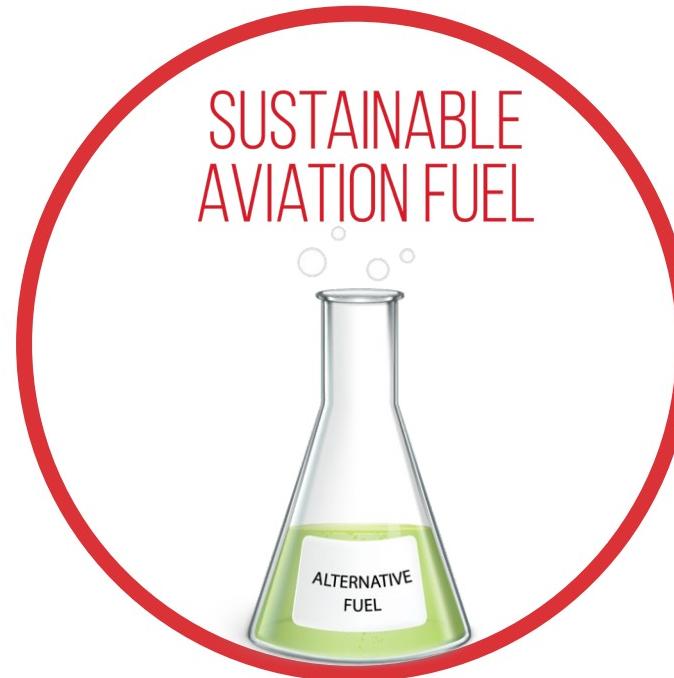
Aviation Pillars for a Sustainable Future



Global Aviation GOAL: net-zero carbon emissions by 2050



NASA = Primary Role



NASA = Supporting Role



NASA = Primary Role

Sustainable Flight National Partnership Benefits



Small Core Gas Turbine for
5%-10% fuel burn benefit
(HyTEC Project)

Electrified Aircraft Propulsion
for ~5% fuel burn and
maintenance benefit
(EPFD & AATT Projects)

Sustainable Aviation Fuels for
reduced lifecycle carbon
emissions
(AATT Project)

Transonic Truss-Braced Wing for
5%-10% fuel burn benefit
(SFD & AATT Projects)

High-Rate Composites for
4-6x manufacturing
rate increase
(HiCAM Project)

Integrated Trajectory Optimization for
1%-2% reduction in fuel required
and minimization of contrail
formation
(ATM-X Project)



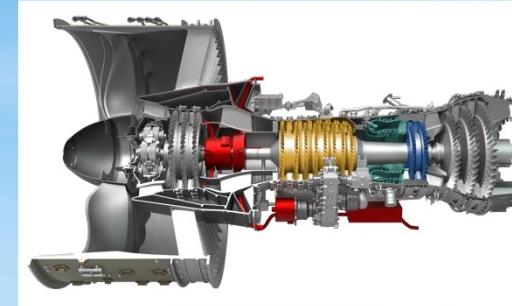


Subsonic Transport Technologies

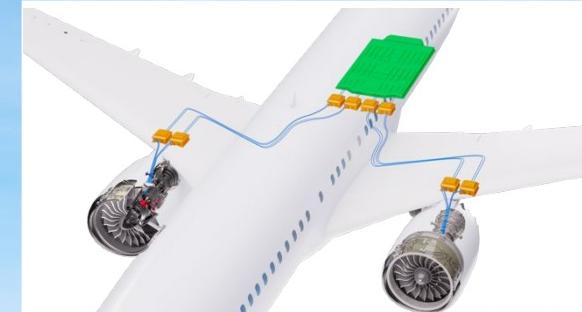
Ensure U.S. industry is the first to establish the new “S Curve” for the next 50 years of transports



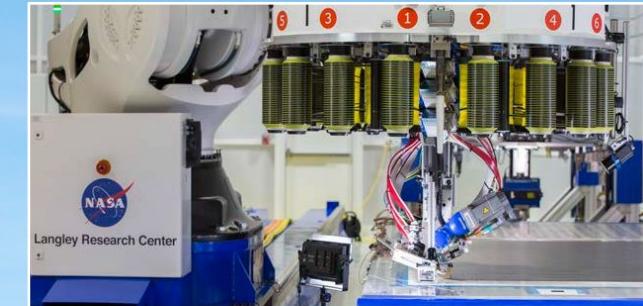
Transonic Truss-Braced Wing
5-10% fuel burn benefit



Small Core Gas Turbine
5-10% fuel burn benefit



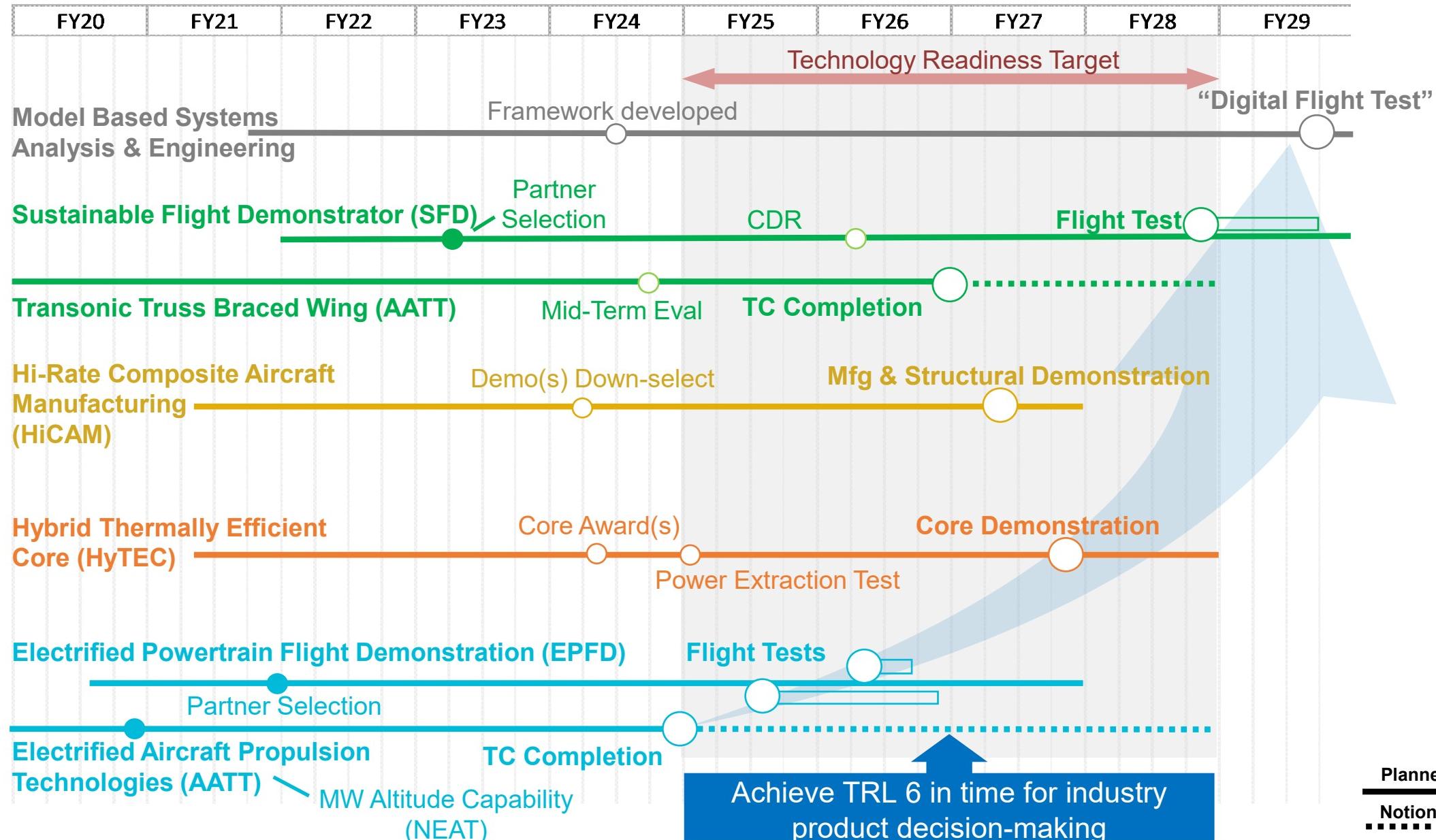
Electrified Aircraft Propulsion ~5%
fuel burn and maintenance benefit

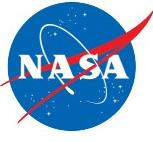


High-Rate Composite Manufacturing
4-6x manufacturing rate increase



Subsonic Transports: Integrated Technology Development





Thrust 4: Safe, Quiet, & Affordable Vertical Lift Air Vehicles



RVLT Provides Tools & Design Practices for UAM eVTOL Vehicles



Thrust 4 Critical Commitment (4.1): Deliver validated tools and recommended practices for **noise and safety** that support the ability to certify and safely operate advanced urban-capable VTOL vehicles in a medium density operational environment.

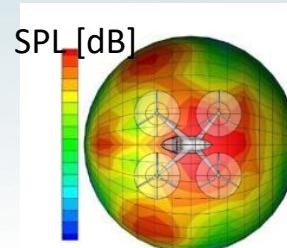
Noise Research



Human Response to UAM Noise



UAM Acoustic Impacts



Predictive Tools for UAM Noise



Share technical insights and lessons learned



Safety Research



Crashworthiness & Occupant Protection



Handling Qualities

Electric Powertrain Reliability

SDOs

Inform eVTOL Systems Standards and Certification

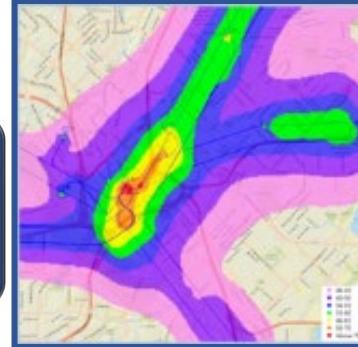
RVLT UAM Noise Research Approach



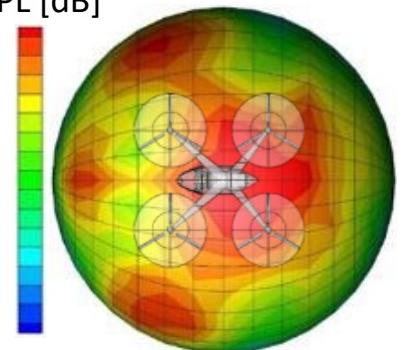
- Sound Auralized
- Annoyance Response
- Acoustic Factors

Psychoacoustic Research
for Human Response to
UAM Noise

Develop and Distribute
Noise Prediction Tools



SPL [dB]



Accurately Model and
Predict UAM Noise Sources

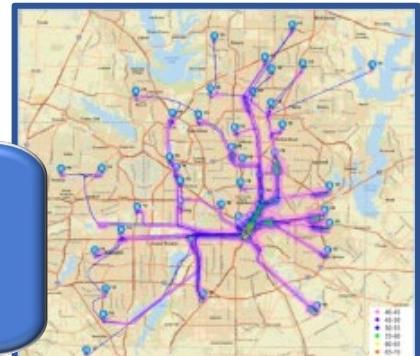


Photo Credit: Joby Aviation

Obtain Flight and Wind
Tunnel Data to
Characterize Noise



Methods for Assessing
UAM Acoustic Impact in
Operations



Provide Design Tools and Guidelines for Low Noise Design and Operations



RVLT UAM Safety Research Approach

Develop Assessment Tools and Guidelines for UAM Modeling

Propulsion: reliability of motors, fault-tolerance, electrical system standards

Handling and Ride Qualities: vehicle response, control system authority, passenger response to motion

Crashworthiness: occupant protection, safety after impact

Use Unique Facilities to Generate Data and Assess New Concepts



Magnetic Gear Motor Prototype



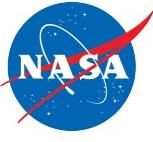
Simulated Operation for Handling Quality Evaluation

Transfer Tools and Data to Regulators, Standards Development Organizations, and User Community



Evaluation of Seats, Subfloor, and Occupant Loads during Impact

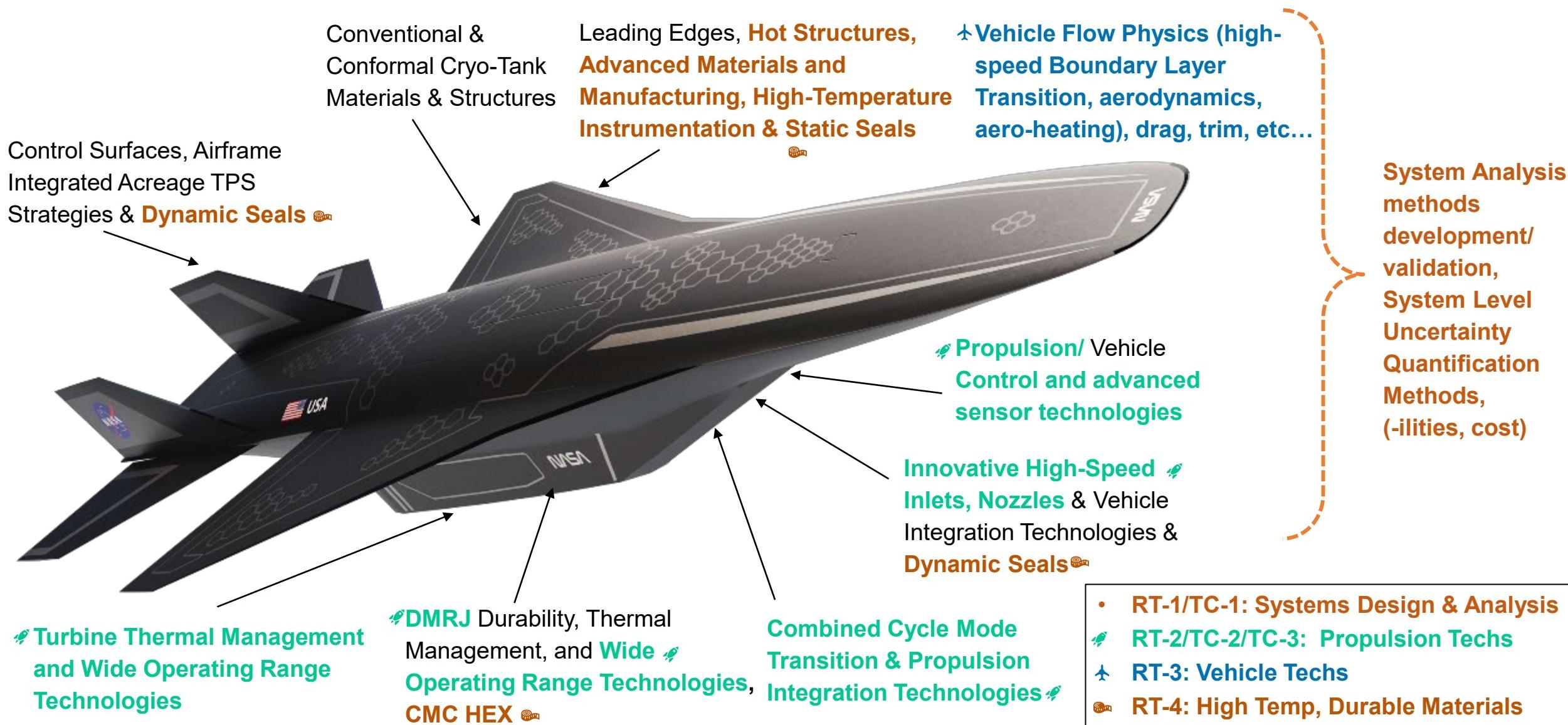
Provide Design Tools and Guidelines for Safe, Reliable Operations and Standards

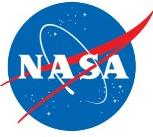


Hypersonics



Common Barriers to Air Breathing Reusable Hypersonic Flight





NASA-DoD Major Collaborations

Hypersonic Airbreathing Weapon Concept (HAWC) USAF-DARPA



- SME support including Airframe IPT lead
- System analysis
- Aero and propulsion analysis ground testing

Advanced Full Range Engine (AFRE) DARPA



- SME support including Propulsion IPT leads
- System studies
- Mode transition design, analysis & testing
- Propulsion testing



HIFiRE-2C AFRL

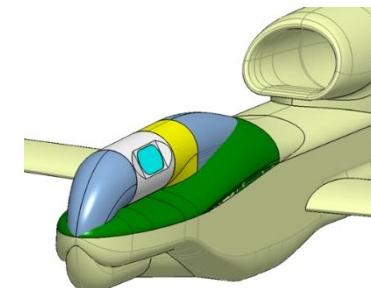
- Joint NASA-AFRL project
- SME support including CE, Co-PI, S&A and ModSim IPT Leads
- Propulsion testing
- CFD

Tactical Boost Glide (TBG) USAF-DARPA



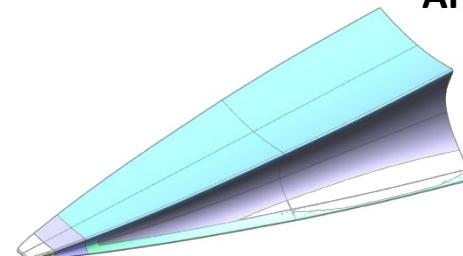
- SME support including Materials IPT lead
- High temp materials analysis, test & database
- Aero/Aerothermal analysis & test

RangeHawk Technology Demonstrations TRMC



- Imaging Instrumentation
- Development and ground test
- Global Hawk Integration
- Flight testing
- Capability Transition Planning

Boundary Layer Transition (BOLT/BOLT2) AFRL-AFOSR



- Testing – ground & launch services
- CFD
- Co-Principal Investigator

NASA's Role in Emerging Commercial High-Speed Market



3 Govt/Industry Workshops held 2020-2022



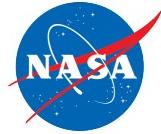
February 2021- Virtual



Industry Feedback On Opportunities/Needs:

- Independent market study
- Hypersonic ground and flight test capability
- Technology development through collaborative agreements
- Regulatory concerns
- International partnerships
- Data protection concerns (export control, classified, CUI, etc.)
- Integration into NAS

Emerging Commercial High Speed Market Key Takeaways



- **Many key barriers for commercial supersonic and hypersonic flight appear to be similar**
 - Significant differences resulting from differences in Mach and associated flight conditions
- **Industry feedback from 3rd High-Speed Commercial Vehicle Workshop (June 2022) reinforces the need for conceptual vehicle studies to assess these barriers and potential solutions in the $2 < M < 5$ range**
- **Contracts awarded Jan 2023 to:**
 - Develop conceptual government reference high-speed vehicle designs
 - Identify the critical technologies that will address the key barriers
 - Develop technology roadmaps that can be used to frame new technical challenges either in CST and/or HTP
- **Non-proprietary concepts will be key for use in regulatory studies**

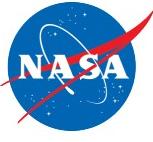


Image Credit: Lockheed Martin

Legacy Supersonic N+2/N+3
Conceptual Designs



Image Credit: The Boeing Company



Wrap-up

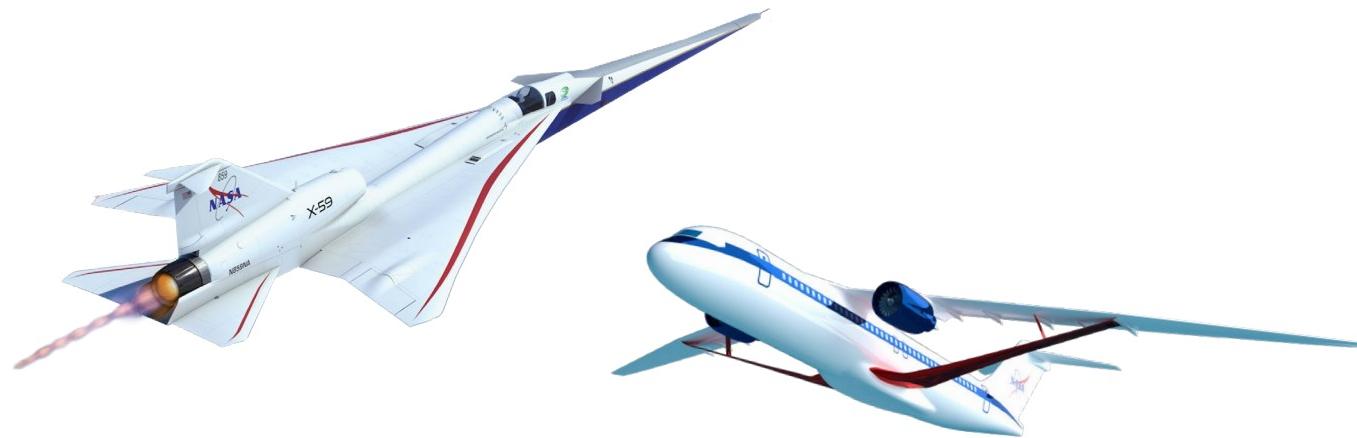
A New Era of Flight is Emerging



Breaking down barriers to open new markets, advance U.S. competitiveness, and make air travel better for all Americans and for people around the world.

Next Generation Subsonic Transports

Making commercial air travel more sustainable



Advanced Air Mobility

Allowing people to move about more easily

Commercial Supersonic Flight

Addressing environmental barriers to connect people faster



Hypersonic Flight

Enabling a future vision for hypersonic transport